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REPRODUCTION IN NORTHERN SEA LIONS ON SOUTHEAST FARALLON ISLAND, 1973-1985

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UNITED STATES DEPARTMENT OF COMMERCE / National Oceanic and Atmospheric Administration / National Ocean Service

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NOTICE

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Reproduction in Northern Sea Lions on Southeast Farallon Island, 1973-1985

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INTRODUCTION

The northern (Steller) sea lion (Eumetopias jubatus) has bred from the Pribiloff Islands in Alaska south to the Channel Islands in California (Scheffer 1958). In the last 50 years the populations south of Alaska have decreased dramatically and breeding on the Channel Islands is intermittent. By the mid 1970's, the numbers of northern sea lions in the eastern Aleutians dropped draticallly (Braham et al. 1980). In the last 10 years pup production in the western Gulf of Alaska has decreased by 26% (Goodwin and Calkins 1985), and the newest evidence from statewide censuses in 1984 and 1985 indicates that the decline involves the population in the rest of the Aleutian chain and the western Gulf of Alaska as well (Merrick, pers. comm.). The population in the Point Reyes/Farallon Island Marine Sanctuary was as high as 900 animals in the 1920's and 1930's (Bonnot et al. 1938); it has been stable at about 130 animals during the breeding season for the last 15 years (Huber et al. 1985). Although a small number of northern sea lions haul out at the Point Reyes Headlands during the breeding season, pupping and breeding take place only at the Farallones within the Point Reyes/Farallon Island Marine Sanctuary boundaries (Allen and Huber 1984).

The reasons for the decline within the Sanctuary are unknown but may be associated with the low natality and high rate of premature pupping found at the Farallones (Huber et al. 1984). Since 1973 when observations by Point Reyes Bird Observatory began, the number of northern sea lion pups born each year ranged from 5 to 27. At the same time the number of pups born prematurely ranged from 1 to 14 (Table 1). Premature pups are seen as early as February and as late as May, but the majority (53/81) occur in

April (Table 2) which indicates that abortion may occur at a specific stage of fetal development. The abortion rate, which averaged 44% over 13 years at the Farallones, is much higher than reported at other rookeries: about 2% at Ano Nuevo Island in central California (Gentry 1970) and 4 to 5% in Oregon (Mate 1975), DeLong pers. comm.). In a recent study in the Gulf of Alaska, Pitcher and Calkins (1981) found evidence of premature pupping in at least 9% of the female northern sea lions collected between February and September. The differences may indicate that the problem is greater at the Farallones than elsewhere or merely reflect the fact that biologists are present on the Farallones year round and only present May to July or August at other rookeries.

Little is known about premature pupping in northern sea lions although the problem is being investigated (Huber et al. 1984, Goodwin and Calkins 1985). However, in the early 1970's researchers on San Miguel Island, California, noted that 20% of the California sea lions were born prematurely. Multiple factors appeared to be associated with the premature pupping including a bacterium, Leptospira interrogans serovar pomona, a calicivirus, San Miguel Sea Lion Virus (SMSV), and increased levels of organocholorines (PCB and DDE) in various tissues (Gilmartin 1976). L. pomona has since been isolated from dead premature or newborn pinniped pups and, in each instance, the isolate was recovered from an animal having "perinatal hemorrhagic syndrome" (Smith et al. 1974). This syndrome is now attributed to Leptospirosis which is associated with reproductive failure in domestic animals. SMSV has been isolated from aborted sea lion fetuses and causes blisters on the flippers of adult animals. Viruses of this kind are known to cause a variety of reproductive-related problems in other species and, presumably, in pinnipeds (Smith et al. 1973). Diagnosis of SMSV is by virus isolation and identification. The levels of PCB and DDE were obtained from the liver, kidney, muscle, blubber and brain tissues of both premature and full-term California sea lions. In general, rising levels were associated with increasing reproductive problems (DeLong et al. 1973). The individual effects and interrelationship among these three factors is not well understood. It is likely that the effects of one exacerbates the stresses of the others.

In 1983 we investigated the high incidence of premature pupping in northern sea lions on the Farallon Islands by laboratory analysis of disease pathogens and pollutants concentrated in the tissues of premature pups (Huber et al. 1984). We found evidence of an unidentified virus in all five of the fresh samples tested. In 1985 we hoped to isolate and identify that virus to more clearly understand the causes of reproductive failure in northern sea lions within the Point Reyes/Farallon Islands National Marine Sanctuary. Unfortunately, the only fetus observed in 1985 washed away before it could be collected. Thus it was not possible to identify the virus found in 1983.

This report will summarize sightings of naturally marked males and females observed on the Farallones during breeding seasons 1978 to 1984, provide updates of the 1984 and 1985 breeding seasons, and compare DDE and PCB levels concentrated in the blubber of five premature fetuses collected 1978 to 1982 with blubber samples of seven premature fetuses collected in 1983.

METHODS

In mid-1973, Point Reyes Bird Observatory (PRBO) biologists began weekly censuses of northern sea lions. Censuses from Lighthouse Hill (elevation 109 m) and other vantage points were conducted between 1300 to 1600 h to obtain maximum counts; animals in the water were included. Since 1976, censused animals were divided into five age/sex classes whenever possible. Beginning in 1973, from February to mid-May, PRBO biologists canvassed the major sea lion pupping areas daily, looking for premature births. When a fetus was found we noted if an adult female was in attendance, her behavior, and if she had a yearling with her. Fetuses were collected for organochlorine analysis whenever it was possible to do so without disturbing other wildlife. Between 1978 and 1982, seven premature fetuses were collected, five were tested for organochlorine residues in the blubber, brain, kidney, muscle and liver, and the remaining two for pollutant residues in the pectoral muscle.

In 1983, funded by the Point Reyes/Farallon Island Marine Sanctuary, all seven pups born prematurely were collected; five within four hours of death. All were necropsied and tested for organochlorine residues in blubber, brain, muscle, and liver. The five fresh fetuses were also tested for the presence of San Miguel Sea Lion Virus (SMSV), Leptospirosis and hemorrhagic syndrome (a symptom of Leptospirosis).

The methods used for organochlorine, viral, and bacterial analysis are described in Huber et al. (1984).

In 1978, after the main pupping area changed from an offshore rock to

Sea Lion Cove, we began records of naturally marked animals to determine if females giving birth to full term pups returned each year, if the same females gave birth prematurely each year, if territorial males returned each year and which males copulated. During the breeding season (mid-May to mid-August), observations of identified animals were made for two to three hours each day, weather permitting. Opportunistic sightings of scarred individuals were made during winter and while looking for premature births at the Farallones, at Point Reyes Headlands in 1982-1984 during another study, and whenever North Farallones were censused. We saw many animals only once. An animal was considered "identified" if it was resighted at least once during a season. At least two and usually three scars or patterns of scars were used in determining whether a rersighted animal was the same as a known animal.

RESULTS AND DISCUSSION

Despite the decline in the population throughout its range and the high rate of premature pupping on the Farallones, the number of northern sea lions on the Farallones during the breeding season has been consistently counted at about 130 animals for the past 13 years (Figure 1).

Although numbers have remained stable, the Farallon breeding population has undergone several shifts in location. Photographs taken in the 1930's show large numbers of northern sea lions hauled out on Indianhead at West End. When PRBO first began observations, all full-term pups were born on Saddle Rock, one quarter mile offshore of Southeast Farallon, although premature pups were seen on the main island. The seasonal pattern was consistent in the early years of observations: resident females hauled out at Sea Lion Cove during fall and winter but as the summer breeding season approached they moved to Saddle Rock where they pupped. In 1976, this pattern changed and adult males and females remained year round in Sea Lion Cove, a more protected and seemingly preferable area. In 1984, northern sea lions were observed on West End for the first time since PRBO biologists began observations, but it was not until 1985 that a pup was born there. Northern sea lions may have moved from Sea Lion Cove to Saddle Rock because of human disturbance during the occupation of the island by the Navy, Coast Guard and Lighthouse personnel; they returned to Sea Lion Cove four years after PRBO imposed restrictions on access to pinniped and bird breeding areas, possibly because of reduced disturbance.

In looking at censuses dividing the population into age classes, we found that adult females are resident on the Farallones year round but that adult males are present only during the breeding season (Table 3). Full-term pups on the Farallones were born between 27 May and 24 July which is a slightly more extended period than at Ano Nuevo Island, California (late-May to mid-July; Gentry 1970), or at Cape St. James, British Columbia (28 May to 14 July; Edie 1977) or at Lewis Island, Alaska, where no pupping was observed after 1 July (Sandegren 1970). Premature pups were born between February and mid-May (Table 3). The proportion of premature pups was higher on the Farallones than at Ano Nuevo, where the proportion is about 2% (Gentry 1970) or in Oregon where it is about 4% (Mate 1975). Seven premature fetuses were collected between 1978-1982 and seven in 1983. Half (7/14) had evidence of perinatal hemorrhagic syndrome which is indicative of Leptospirosis, nearly 80% (11/14) had inflated lungs indicating they were alive at birth. In all, there were 8 males and 6 females. Fetuses collected between 1978-1982 were tested only for organochlorines in the tissues. All seven fetuses from 1983 were tested for organochlorines and five of these were fresh enough to be tested for the presence of SMSV and Leptospirosis. No evidence of SMSV was found, and only one sample had antibodies to Leptospirosis. All five samples contained an influenza-like virus that could not be replicated because of logistic problems causing repeated freezing and thawing and therefore not possible to identify. This same virus was also present in premature pups at Rogue Reef.

We had hoped to collect more samples in 1985 that would enable us to identify the influenza virus and determine if it was responsible for the high rate of premature pupping. However, only one premature pup was born in 1985 and it was not available for collection.

Between 1978-1983, we identified 21 adult males by natural markings. More than half (12/21) were seen in more than one season (Table 4). All males resighted were seen in successive years: no resighted males "skipped" seasons. Seven of the 12 males seen for more than one year held territories, one for six years, one for four years, and three for three years. The resighted males without territories were generally seen early or late in the breeding season and may have been enroute to or from the nearby Ano Nuevo rookery. At least two males were seen at the Point Reyes Headlands in the same year they were present on the Farallones, but neither held a territory at the Farallones. No males could be identified at the

North Farallones, and thus, whether there is interchange between North and South Farallones is not known.

We identified 25 different females, 70% of which were seen for more than one breeding season. Sixty percent were never seen with a pup; three were seen with full-term pups and seven with premature pups (Table 5). Only two females were observed in non-consecutive seasons and neither was ever seen with a pup. One female raised a full-term pup successfully for three consecutive years. Less than 20% (15/81) of the premature pups found had females in attendance. Those females associated with premature pups were not seen with a premature pup in more than one season, nor with a full-term pup in any season, nor with a nursing yearling. Although no females were seen with premature pups in more than one year, only 1/5 of premature pups were seen with attendant females, therefore it is not possible to say whether the same females are giving birth to premature pups year after year. Most of the 15 females seen with premature pups were very attentive to those pups even if the pup was dead. Some females protected their dead pups from scavenging Western Gulls. Two females even carried dead pups into the water and swam off with them.

The majority of identified females were not seen with pups and may have been females which gave birth at some other rookery and were seen on the Farallones only during feeding bouts or before parturition. At least five females were seen during the winter on the Farallones and two others at the Point Reyes Headlands during other censuses.

Within the breeding season, resightings of males without territories and females without pups were lower than territorial males or parturient females. This is partially because non-breeding animals are more likely to move out of the area than breeders and partially because the pup or territory serves as an additional clue to the individual's identity. Resightings also increased when the number of observers was limited to those familiar with the scars. Resightings were a function of the distinctiveness of marks combined with visibility, e.g., belly scars which are visible only when a female is nursing, although distinctive, are less useful than those which are visible from more angles. Based on sightings of identified males and females, males copulated with females 10-14 days after parturition; at least 20% of copulations observed were with non-parturient females.

Robert Risebrough of Bodega Marine Laboratory analyzed DDE and PCB levels in tissues from premature pups collected in April: 3 from 1978, 1 from 1980, and 3 from 1982 (Table 6). Samples were taken from the brain, blubber, liver, kidney and/or pectoral muscle. Results were similar to those in 1983 (Huber et al. 1984). At least five pups collected between 1978-1982 were born alive but died within several hours as was true for six of seven pups in the 1983 sample (one sample was not checked). Since organochlorines concentrate in the blubber layer, we tested the five blubber samples from 1978-1982 against the seven blubber samples obtained in 1983. The levels of DDE in the blubber were similar in the two sets of samples ($t=1.637$, $df=10$, $p<.20$). The same was true for PCB levels ($t=.3519$, $df=10$, $p<.50$). Five of seven pups in the 1978-1982 sample showed evidence of perinatal hemorrhagic syndrome which is symptomatic of Leptospirosis. Only two in the 1983 sample showed evidence of

Leptospirosis. No pups in the 1978-1982 sample were tested for the influenza-like virus found in five of seven in the 1983 samples. In both samples, DDE and PCB residues concentrated in the blubber layer and samples with high levels of DDE also had correspondingly high levels of PCB. However, Jones (cited in Reijnders 1980) discovered that high levels of PCB and DDE found in fetuses are not necessarily related to correspondingly high levels of pollutants in the maternal blubber, possibly because adult females lose pollutant residues when their fat is metabolized during parturition and lactation.

In 1984, six pups were born, one prematurely on 22 March. Pup mortality was 33% that year. Between 23 April and 17 July, 1985, seven pups were born, one prematurely. Pup mortality was 28% in that year (Table 5). It was not possible to collect either fetus for analysis.

In summary, we have determined that premature pupping is more extensive on the Farallones than in other areas, that disease and concentrations of PCB's or some combination of the two may be contributing to premature pupping, and that there is a world-wide decline in the northern sea lion population. Nonetheless, we do not yet know the cause of the decline, the cause of the premature pupping, nor the relationship (if it exists) between the two. Recent research has opened up more questions to be investigated. Reijnders (1984) suggests that mercury, selenium and cadmium concentrations, which may have severe consequences on reproductive rates in pinnipeds, should be assessed. Goodwin and Calkins (1985) feel that Chlamydiosis may contribute to reproductive failure in the western Gulf of Alaska. Other researchers feel the decline may be ascribed to changes in prey availability, entanglement of juveniles in discarded fishing gear or disease or some combination of these factors (Merrick, pers. comm.). Further investigations of the problem should concentrate on these questions and determine if there are different causes in different areas for the overall population decline.

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Table 1. Reproductive success of female northern sea lions on Southeast Farallon Island, 1973-1985.

YEAR	HIGHEST NUMBER OF FEMALES PRESENT	NUMBER OF PUPS BORN	PERCENT NATALITY	NUMBER OF PREMATURE BIRTHS	PUP DEATHS - OTHER CAUSES	PERCENT MORTALITY
1973	73	9	12	3	-	33
1974	110	10	9	4	-	40
1975	98	19	19	4	5	47
1976	98	14	14	5	1	43
1977	111	27	24	11	-	41
1978	103	18	17	10	-	56
1979	96	15	15	3	3	40
1980	91	26	29	14	2	61
1981	86	17	20	11	-	64
1982	99	12	12	7	1	67
1983	79	10	13	7	2	90
1984	90	6	7	1	1	33
1985	80	7	8	1	1	28

Table 2. Number of premature northern sea lion pups born on Southeast Farallon by month, 1973-1985.

YEAR	FEB	MAR	APR	MAY
1973	1	1	1	
1974			3	1
1975			4	
1976			3	2
1977		3	6	2
1978		3	6	1
1979			3	
1980			7	7
1981		4	7	
1982			6	1
1983			6	1
1984		1		
1985			1	
Total	1	12	53	15

Table 3. Reproductive chronology in northern sea lions on South Farallon Islands, 1973-1985.

YEAR	BULLS PRESENT	PREMATURE PUPS BORN	FULL-TERM PUPS BORN	COPULATIONS OBSERVED
1973	16 Apr-<17 Jul	7 Feb- 9 Apr	<17 July	--
1974	29 Apr- 8 Aug	10 Apr-15 May	3 Jun-11 Jul	--
1975	10 Apr-22 Aug	11 Apr-18 May	6 Jun-12 Jul	--
1976	18 Apr-29 Jul	17 Apr-19 May	5 Jun-28 Jun	--
1977	15 Apr-11 Aug	29 Mar- 5 May	27 May- 5 Jul	11 Jun
1978	18 Apr- 3 Aug	11 Feb-12 May	3 Jun-30 Jun	18 Jun-12 Jul
1979	2 May-15 Aug	17 Apr-28 Apr	12 Jun-12 Jul	27 Jun- 3 Jul
1980	4 May- 6 Aug	3 Apr-11 May	12 Jun-24 Jul	11 Jun-29 Jun
1981	28 Apr-10 Aug	17 Mar-28 Apr	10 Jun- 7 Jul	28 Jun
1982	1 May-30 Jul	1 Apr-18 May	16 Jun- 3 Jul	24 Jun
1983	2 May- 1 Aug	7 Apr-11 May	22 Jun-26 Jul	20 Jun
1984	5 May-28 Jul	22 Mar	15 Jun-28 Jun	27 Jun
1985	6 May- 8 Aug	23 Apr	7 Jun-26 Jun	18 Jun

Table 4. Adult male northern sea lions identified by natural markings at Southeast Farallon Island 1978-1983. (T indicates territory held, X indicates present during breeding season.)

IDENTIFIED MALE	1978	1979	1980	1981	1982	1983
1	T	T	T	T	T	T
2	T	T	T			
3		T	T	T		
4		T				
5		X				
6		X				
7		X				
8		X	X			
9			X	X	X	
10			T	T	T	T
11			X			
12			T	T	T	
13			T	T		
14			T	T		
15				X	X	X
16				X		
17				X	X	X
18					X	
19					X	X
20						T
21						T

Table 5. Adult female northern sea lions identified by natural markings at Southeast Farallon Island, 1978-1983 (F = full-term pup, N = not observed with pup, P = premature pup).

IDENTIFIED FEMALE	1978	1979	1980	1981	1982	1983
1	N	N				
2	N	N				
3	N	N				
4	N	N				
5	N		N			
6		F	F			
7		F	F	F		
8		N	N	N	N	
9		N		N		
10		N	N			
11		N	P			
12			P	N		
13		N	P	N	N	
14			N	N		
15		N	N	N	N	N
16		N	N			
17			N	P		
18				P		
19			N	N		
20		N	N	N		
21				P		
22				P		
23				F	N	
24				N	N	
25					N	N

Table 6. DDE and PCB levels in tissues of premature fetuses of the northern sea lion from the Southeast Farallon Island, 1978-1982.

BML ID	DATE COLLECTED	TISSUE	% H O	P,P'-DDE PPM DRY	PCB PPM DRY
82-58	6 Apr 1980	Blubber	65	13	9.5
82-55		Brain	36	0.7	0.9
82-56		Liver	74	0.3	0.4
82-57		Pectoral muscle	85	11.8	9.6
82-59		Kidney	82	0.5	0.6
82-18	1 Apr 1982	Blubber	64	31	18
82-18		Brain	91	4	1.9
82-18		Liver	76	0.4	0.6
82-18		Pectoral muscle	81	17.6	10
82-18		Kidney	81	1.3	0.9
82-19	12 Apr 1982	Pectoral muscle	90	8.3	3.9
82-60	13 Apr 1978	Blubber	69	83	76
82-60		Liver	82	4.4	4
82-60		Pectoral muscle	82	6.5	5.4
82-61	11 Apr 1978	Blubber	75	40	33
82-61		Brain	95	13	13
82-61		Liver	81	9.6	7.1
82-61		Pectoral muscle	89	15	14
82-61		Kidney	95	6.7	16
82-66	April 1978	Blubber	79	6.6	2.3
82-66		Brain	91	0.5	0.4
82-66		Liver	76	0.7	
82-66		Pectoral muscle	94	7.5	3.1
82-66		Kidney	82	0.5	0.1
82-65	7 Apr 1982	Pectoral muscle	82	15	4.6

Fig. 1. The occurrence of northern sea lions (Eumetopias jubatus) on the Farallones, 1971-1985.